THE TUFACEOUS DEPOSITS OF THE TEST AND ITCHEN.

By J. T. Kemp, M.A.

Associated with the peat which borders the courses of the Test and Itchen and their tributaries are frequent deposits of tufa or freshwater marl. Some of them in the neighbourhood of Romsey and Mottisfont were described by Sir Charles Lyell in a paper read before the Geological Society in 1824,* when the tufa (locally known as "malm") was dug for agricultural purposes. The pits having long been closed and the peat being rarely excavated for other purposes, good sections are now seldom to be seen.

During the last two years however the excavation for the new dock at Southampton has revealed numerous tufaceous deposits in the peat at the junction of the two rivers, while the dredging operations for the purpose of cutting a channel through Netley Shoal have proved their extension beneath the marine mud still further down the Water. In both cases my thanks are due to Mr. Shore for the facilities I have had for studying the deposits. The results are described in the present paper, which also includes some account of the marl in other localities along the two valleys.

In addition to Lyell's paper several other references to the subject may here be noted.

The employment of the tufa in agriculture both in the Test valley and in the Isle of Wight (where similar deposits occur in the alluvium of the Western Yar) is described by C. Vancouver in "A General View of the Agriculture of Hampshire, including the Isle of Wight, drawn up for the Board of Agriculture and Internal Improvement," London, 1810.

* On a recent formation of Freshwater Limestone in Forfarshire, and on some recent Deposits of Freshwater Marl. Trans. Geol. Soc., Ser. 2, vol. ii, p. 73.

The two following papers are probably well worth perusal, though I have not read them myself:

Bowerbank, J. S. An account of a deposit containing land shells at Gore Cliff, Isle of Wight. Proc. Geol. Soc., vol. ii, p. 449.

Sorby, H. C. On the Microscopic Structure of some British Tertiary and Post-tertiary Freshwater Marls and Limestones. Quart. Journ. Geol. Soc., vol. ix, p. 344.

The latest paper on the subject is that of Mr. Shore "On the Beds exposed in the Southampton Dock Excavation," which was read at the meeting of the British Association at Bath, 1888.

Mr. Clement Reid of H.M. Geological Survey has visited the Dock and made a small collection of organic remains from the tufa, which are now in the Museum of the Hartley Institution.

At the Dock the tufa is seen forming pockets and irregular layers, usually more or less lenticular, lying in the peat. The thickness of the layers averages from two to three feet, but occasionally rises to five and probably more. Their diameter is often many yards. Sometimes they are sharply marked off from the peat both vertically and laterally, but at others they shade into it imperceptibly through peaty tufa and tufaceous peat. Not unfrequently a bed ends abruptly with a vertical junction between it and the peat. In such a case it probably occupies an eroded hollow. The deposits occur at various levels, one occasionally being seen directly above another. They often possess a distinctly stratified character, exhibiting layers, sometimes less than an inch thick, of different shades of grey and white. Trunks of trees sometimes occur in them, round which the layers curve. Other characters of the tufa are described in a later part of the paper.

Netley Shoal being permanently under water it is impossible to give an exact account of its structure. The moterials brought up by the dredger prove it to consist of Bracklesham deposits, coarse gravel, peat and tufa, with a covering of marine mud. From its form and position it is evident that it is a hummock of these materials left by the erosion of channels through the alluvium into the Tertiaries on each side.

In the higher parts of the two valleys the tufa frequently occurs at the surface of the peat, though deposits probably exist at all levels. Along the Test surface deposits are numerous between Mottisfont and Fullerton; they extend also into the Anton valley. They occasionally occur below Romsey, at least as far as Lee. They usually form level terraces, or plateaux, which Lyell states were known as "malm-knolls," elevated three or four feet above the peat. A fine example can be seen from the railway line, on the left-hand side in approaching Horsebridge from Mottisfont; the spot may be identified by the hillocks of marl thrown out by rabbits. Malm-knolls can in fact very often be detected by the labours of burrowing animals. Sections of the deposits are often to be seen in ditches, as for instance, along the Stockbridge road between the Bear and Ragged Staff and Brook. The best section of this kind I have met with is in a deep drain near Lee, where a deposit of rather impure tufa, two or three feet thick, is exposed in the peat a little below the surface, with four or five feet of black peat under it. Occasionally the river cuts through a knoll, as at Lower Brook.

Owing to the present scarcity of good sections, showing the relations of the alluvial deposits of the Test, I quote the following from Lyell's paper, the locality being Ashley Meads, where the tufa used to be dug.

1.—Alluvial Clay unmixed with marl	1 to 2 feet.
2.—Shell Marl, provincially termed "malm" ..	2 to 6 ,,
3.—Peat of various kinds, sometimes	6 ,,
4.—Clay and Gravel (Diluvium)	

Lyell accounts for the existence of malm-knolls by the peat contracting to a large extent after its formation through pressure, while the tufa does not; consequently when sufficiently thick deposits of the latter exist near the surface of the peat, they are left standing up as plateaux.

The occurrence of the tufa in the Itchen Valley is similar to that above described. Malm-knolls abound between Bishopstoke and Winchester. Very fine sections of pure tufa exceeding six feet in thickness are exposed along the river bank near the Southampton Waterworks. I cannot find that the marl was ever dug in the Itchen Valley as an article of commerce.

The tufa may be described as essentially a granular deposit of carbonate of lime, with a variable admixture of peaty or earthy matter. It is often crammed full of land and fresh-water shells, but sometimes contains hardly any. A large portion of the carbonate of lime is often compacted into nodules of various sizes and shapes, which may or may not contain a central nucleus, such as a plant-stalk, a shell or a fragment of stone, round which the calcareous matter is deposited in visible layers differing slightly in texture or colour. Not infrequently however the nodules are to all appearance quite amorphous. Nodules without recognisable nuclei were in many cases probably formed round fragments of pre-existing concretions. The commonest shapes assumed by nodules are spherical and cylindrical, the latter being almost invariably formed on plant-stalks. Very thin concretions sometimes occur, which when broken reveal the remains of a leaf. Spherical and irregular nodules may have any kind of a nucleus. Sometimes the carbonate of lime is entirely in a finely divided state, giving the tufa, when wet, the consistency of mortar.

While it often happens that nodules are formed round shells, the great majority of shells in the tufa have no calcareous matter actually attached to them, nor are they filled with calcareous or other matter. The easiest method of separating them from the matrix, therefore, is to dry it thoroughly and break it up under water, when the bulk of them (with the exception of the bivalves and patelliform univalves) immediately rise to the surface and can be skimmed off. Some species assume a calcareous coating much more frequently than others, but none more frequently than the Bithynia. (According to Dillwyn this sometimes happens when the animal is alive.) Other species often coated are the Limnæae, Helix nemoralis, Valvata piscinalis, Planorbis albus, P. contortus. Physa fontinalis seems never to have contracted a calcareous coating, perhaps on account of its smooth surface. With the exception of this and probably Zua lubrica (which is scarely abundant enough to warrant any definite assertion) almost every species is found occasionally with attached calcareous matter. Species very rarely coated are Succinia elegans, Ancylus lacustris, Helix rotundata, and the Pisidia.

The natural transparency of many shells is almost invariably lost, Achatina acicula being a notable exception. Their colour is sometimes preserved, oftener in some localities than in others. At Southampton Dock and Netley Shoal the tufa is highly nodular as a rule, but the size of the concretions is comparatively small. The colour is white or grey with a bluish tinge especially in the Shoal. The nodules can generally be broken with the fingers, but a hammer is occasionally required. Plant remains are extremely common in them. Small fragments of flint often occur in the Netley nodules. The shells at both localities, but especially Netley, are very often stained dark blue, sometimes entirely, sometimes only partially. Like the calcareous coating, this coloration affects some species much more than others. The following are very liable to it: Bithynia tentaculata, Valvata piscinalis, Helix nemoralis, the Linnæœ, Ancylus fluviatilis. Succinea elegans I have never found stained. The following species are very rarely blue: Planorbis albus, P. contortus, Valvata cristata, Helix rotundata, Physa fontinalis, the species of Pupa, Vertigo and Pisidium. It is interesting to note that the two very rare (at the Dock) species of Planorbis, viz.: P. complanatus and P. spirorbis are both known in the stained condition. Valvata cristata appears to be stained in the Shoal only, where the colouring in other cases is more frequent than at the Dock. Planorbis fontanus and P. nautileus (neither of them very common, however) I have never found stained.

As to colour, the natural markings of Helix rotundata are usually preserved, when not stained, and occasionally those of H. nemoralis. The various species of Pupa, Vertigo, Clausilia, and Balea usually retain their colour in some degree. These rules hold good for all localities.

The existence of maritime conditions during the formation of the tufa at Netley Shoal and, to a less extent, at the Dock is indicated by the dwarfed appearance of various species in these localities as compared with specimens from places higher up the streams. At the Shoal Bithynia tentaculata, Valvata piscinalis, Limnæa peregra and Planorbis contortus do not attain more than half their natural size, the first two being slightly dwarfed at the Dock. The Netley specimens of V. cristata are also decidedly stunted.

In the valley of the Test I have, as before stated, traced the occurrence of the tufa from Lee to Fullerton. It is, as Lyell notes, very frequently stained with ferric oxide, both above and below the junction of the chalk with the Tertiaries at Mottisfont. The shells are mostly coloured in the same way, but neither here nor in the Itchen valley is the blue coloration so frequent at the Dock ever found. The nodules appear generally to be very irregular in form and much looser in texture than at Southampton.

In the Itchen valley, the tufa, so far as I have examined it, is of a uniform cream colour, the shells (except when retaining their natural colour) being remarkable for their whiteness; they have been in fact bleached without being subsequently stained. The nodules also are unusually large and compact, a hammer being frequently required to break them. Near the Waterworks I have observed the formation of a continuous layer of calcareous matter. Nodules weighing from 2 to 3oz. are common.

In conclusion I give a list of the shells from the several localities so far as I have been able satisfactorily to identify them. In this Mr. B. B. Woodward, of the Natural History Museum, has rendered valuable assistance, especially in the determination of the species of Pupa and Vertigo. The species of Hyalinia have also all been determined by him.

In the list, the species marked as occurring at Netley Shoal were found in material brought up by the dredger; those from the Dock have all been either picked up or washed out of material collected on the spot by Mr. Elwes or myself. The Test valley species have all been obtained from the neighbourhood of Mottisfont, with the exception of those marked L or A, the former being taken from the list given in Lyell's paper while the latter are a few picked out of mole-hills on a malm-knoll in the Anton valley. The specimens from the Itchen valley were collected in the river-side exposure previously mentioned.

The letter c stands for common, cc for very common, r for rare, rr for very rare. My collection from the Itchen valley being at present but scanty I have not ventured to indicate relative degrees of abundance or scarcity, but merely use an asterisk to denote the occurence of each species found. The

highest value attaches to the letters relating to the Dock, as my researches have been much more extended in that locality than anywhere else.

UNIVALVES.

		Netley Shoal.	So'ton Dock.	Test Valley.	Itchen Valley.
1	Achatina acicula	—	—	rr	*
2	Ancylus fluviatilis	c	c	c	*
3	A. lacustris	c	c	c	*
4	Balea perversa	c	r	c	—
5	Bithynia tentaculata	c	cc	cc	*
6	Carychium minimum	cc	c	c	*
7	Clausilia rugosa	r	r	—	—
8	Cyclostoma elegans	—	—	A	—
9	Helix arbustorum	—	rr	AL	*
10	H. concinna	—	rr	r	*
11	H. ericetorum	—	—	—	*
12	H. hispida	—	—	rr	—
13	H. nemoralis	—	c	c	*
14	H. pulchella	—	rr	rr	*
15	H. rotundata	c	c	c	*
16	H. rufescens	—	—	A	*
17	Hyalinia crystallina	c	r	c	—
18	Hyal. fulva	—	rr	r	—
19	Hyal. nitida	—	c	c	—
20	Hyal. nitidula	—	c	r	*
21	Hyal. radiatula	c	r	c	—
22	Limnœa auricularia	—	—	L	—
23	L. palustris	r	c	c	—
24	L. peregra	cc	cc	cc	*
25	L. stagnalis	—	c	c	*
26	Physa fontinalis	r	c	c	*
27	Planorbis albus	—	cc	cc	*
28	P. carinatus	—	—	L	—
29	P. contortus	c	cc	cc	—
30	P. fontanus	r	r	r	—
31	P. nautileus	c	r	c	—
32	P. spirorbis	r	rr	cc	*
33	P. vortex	—	rr	—	—
34	Pupa muscorum	—	rr	c	—
35	P. umbilicata	r	r	—	—
36	Succinea elegans	—	c	c	*
37	S. putris	—	—	L	—
38	Valvata cristata	c	c	c	*
39	V. piscinalis	cc	cc	cc	*
40	Vertigo antivertigo (Drap.) ..	—	r	—	—
41	V. edentula	rr	—	—	—
42	V. pusilla	r	r	c	*
43	V. pygmæa	—	—	rr	—
44	V. substriata	—	—	rr	—
45	Zua lubrica	—	r	c	*

BIVALVES.

46	Cyclas cornea	—	—	L	—
47	Pisidium amnicum	—	c	c	*
48	P. fontinale	—	—	c	—
49	P. nitidum	c	c	c	*
50	P. pusillum	c	c	c	*